ICCARUS Offenbach, 2019

ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

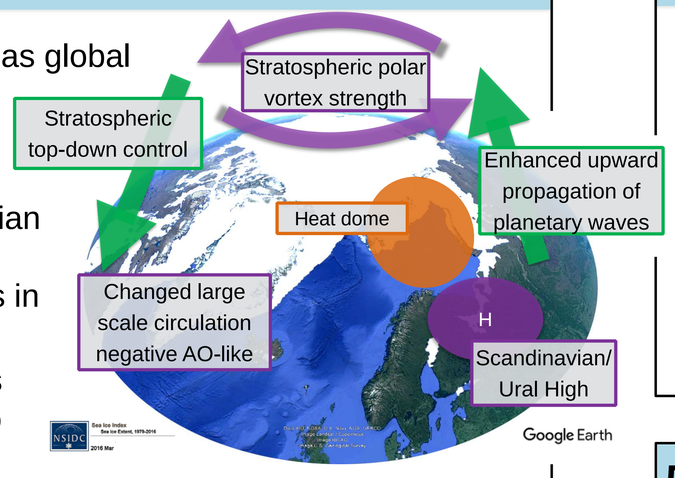
Contact: Raphael.Koehler@awi.de

Raphael Köhler, Ralf Jaiser, Dörthe Handorf, Markus Rex, Klaus Dethloff

ICON-NWP: Analysis of stratospheric processes in Northern Hemisphere winter

1) Hypothesis for impact of sea-ice loss

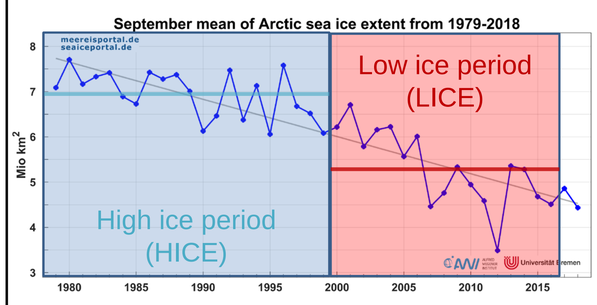
- Arctic warming (AW) is twice as strong as global average [1]. Majority of AW can be explained by feedbacks associated with diminishing sea ice cover *[2]*.
- AW favours development of Scandinavian high pressure anomaly and enhanced upward propagation of planetary waves in early winter *[3]*.
- Wave breaking in stratosphere reduces strength of polar vortex and can lead to break down of the polar vortex [4].
- Stratospheric top-down control changes atmospheric circulation patterns, favouring a negative AO-like pattern in late winter, thereby affecting mid-latitude weather patterns *[3,5]*.



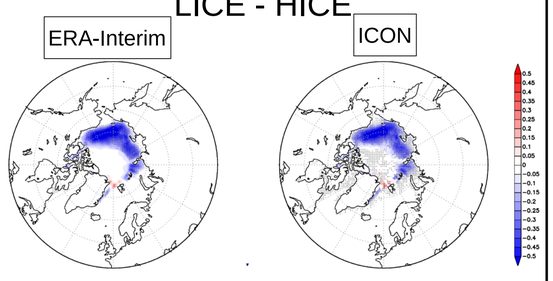
2) Set up: Seasonal model climatology

Model	ICON-NWP
Seasonal experiments	September – May
Horizontal resolution	R2B5 (~ T159)
Vertical resolution	90 model levels up to 75km
Boundary data	CMIP6 SSTs, sea ice and VMR
Initial data	ERA-Interim data
Simulated years	1979/80 – 2016/17
Ensemblesize	5 (01. Sept. 00Z ± 2x6h)
Sea and lake ice	Bulk thermodynamic (no rheology) sea-ice parametrisation scheme (Mironov, 2012)

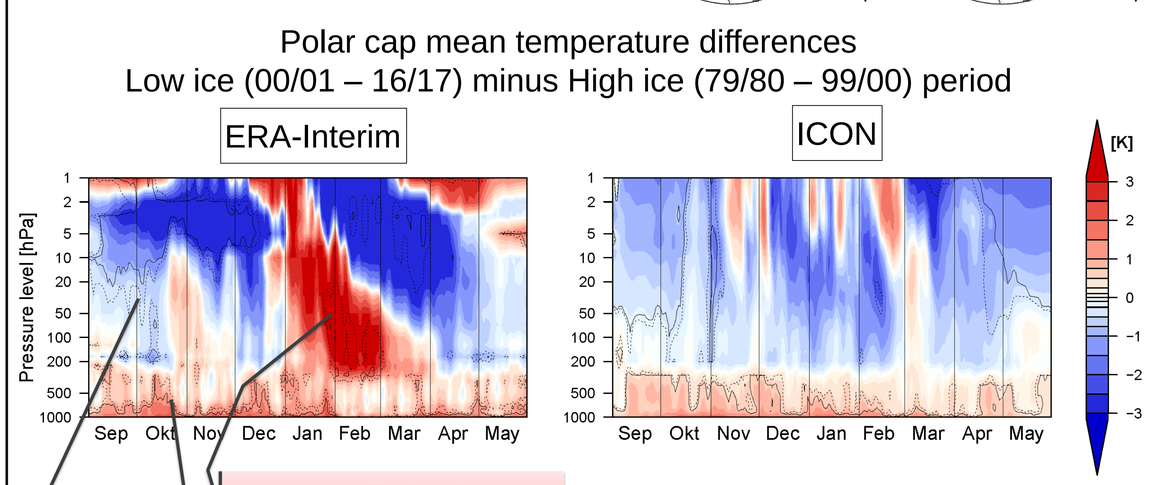
3) Effect of Arctic sea ice loss?



Sep. sea ice content differences LICE - HICE

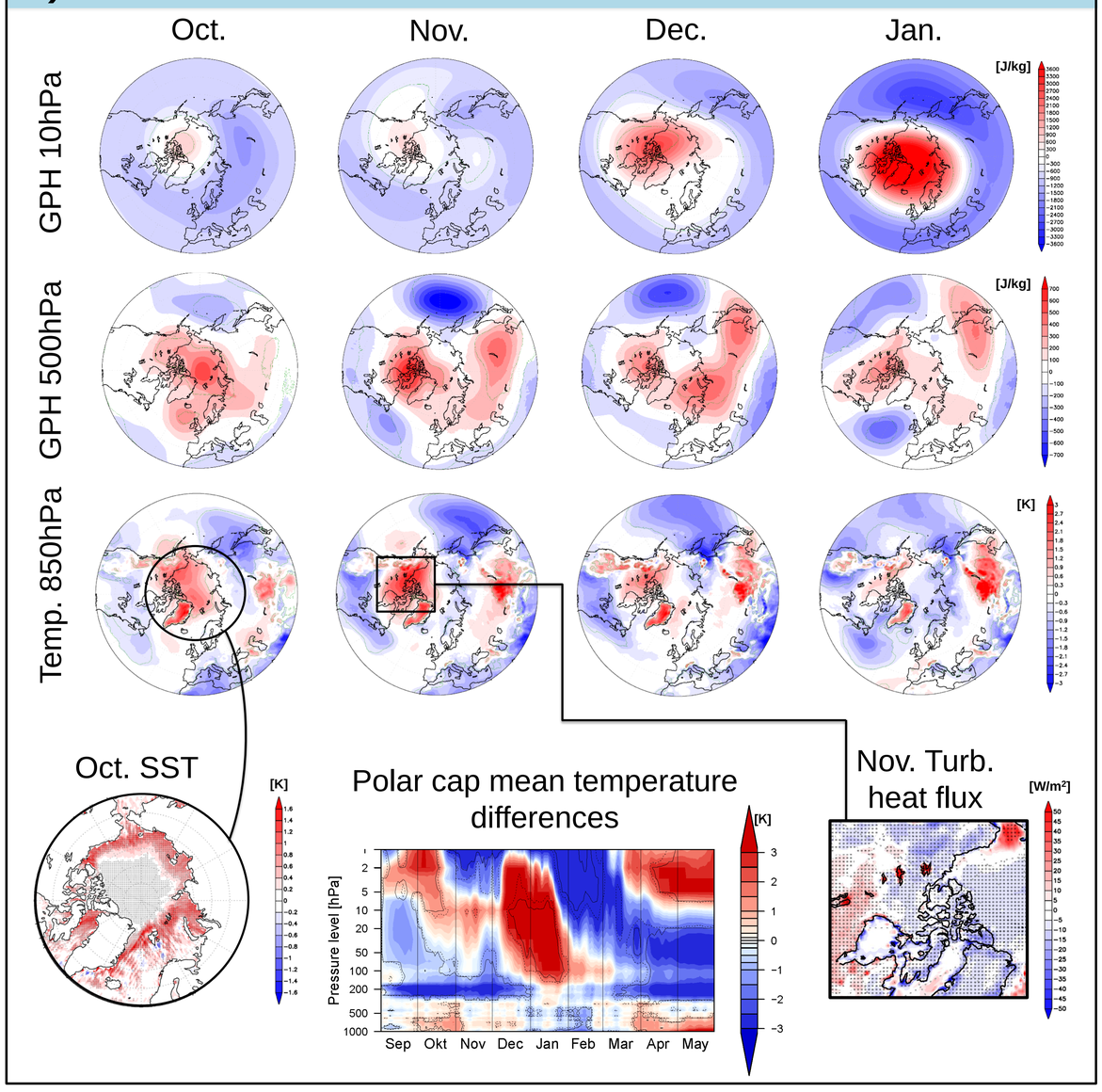


Polar cap mean temperature differences
Low ice (00/01 – 16/17) minus High ice (79/80 – 99/00) period



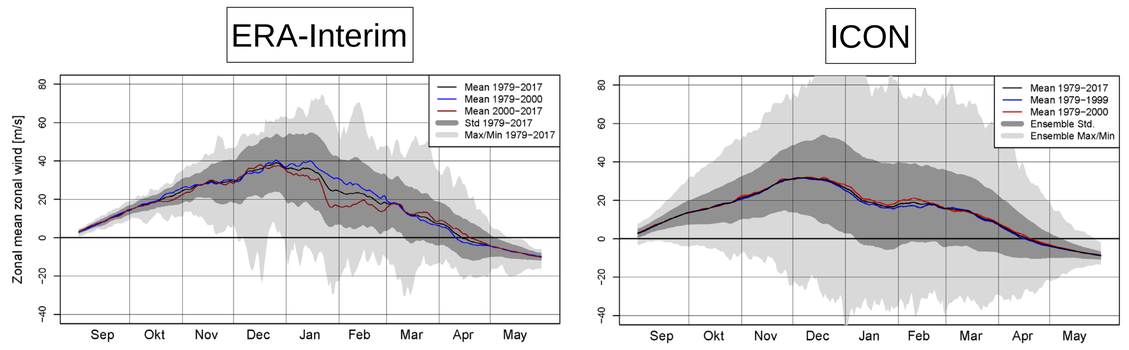
ICON:
- Tropospheric warming ✓
- Stratospheric cooling ✓
- Midwinter stratosphere warming ✗
- Missing troposphere-stratosphere coupling in ICON?

5) ICON minus ERA-Interim

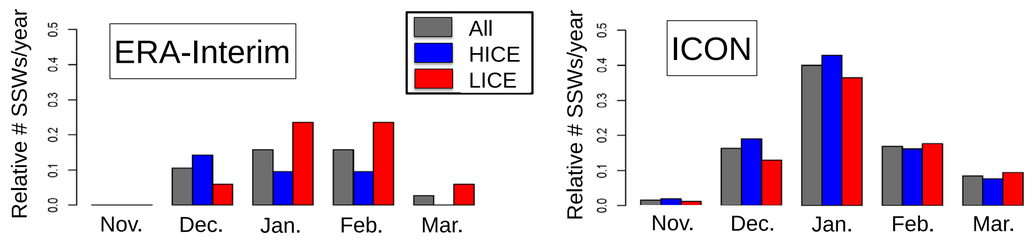


4) Polar vortex climatology

Zonal mean zonal wind in 60°N and 10hPa



SSWs per year and month



Stratospheric behaviour in ICON:
- High extrema
- Strong variability
- Weak vortex in January

References
[1] Cohen, J., et al. "Recent Arctic amplification and extreme mid-latitude weather." Nature geoscience 7.9 (2014): 627.
[2] Screen, James A., and Jennifer A. Francis. "Contribution of sea-ice loss to Arctic amplification is regulated by Pacific Ocean decadal variability." Nature Climate Change 6.9 (2016): 856.
[3] Crasemann, B., et al. "Can preferred atmospheric circulation patterns over the North-Atlantic-Eurasian region be associated with arctic sea ice loss?." Polar Science 14 (2017): 9-20
[4] Jaiser, R., et al. "Atmospheric winter response to Arctic sea ice changes in reanalysis data and model simulations." Journal of Geophysical Research: Atmospheres 121.13 (2016): 7564-7577.
[5] Handorf, D., et al. "Impacts of Arctic sea ice and continental snow cover changes on atmospheric winter teleconnections." Geophysical Research Letters 42.7 (2015): 2367-2377.

Universität Potsdam
POLMAR Helmholtz Graduate School for Polar and Marine Research
AWI ALFRED-WEGENER-INSTITUT HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG
HELMHOLTZ SPITZENFORSCHUNG FÜR GROSSE HERAUSFORDERUNGEN

Potsdam

Telegrafenberg A45
14473 Potsdam
www.awi.de